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ESTEREOLOGÍA Y ANÁLISIS DE IMAGEN: DE LA MATEMÁTICA A LA MEDICINA CLÍNICA

X. Gual-Arnau

Departamento de Matemáticas.



Universitat Jaume I.

Castelló (SPAIN)

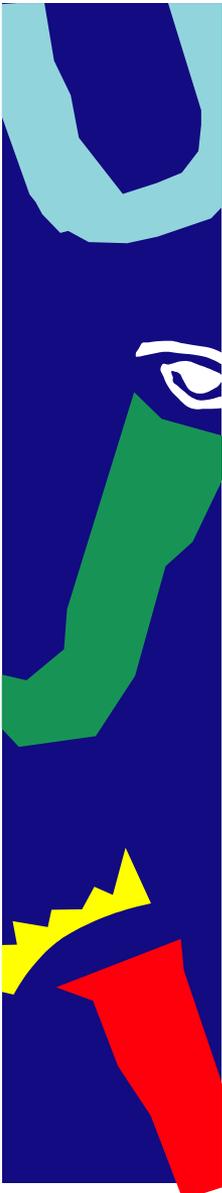
gual@mat.uji.es





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L. A. Santaló, L. M. Cruz-Orive, A. M. Naveira. Girona, 1990





- **Estereología y análisis de imagen**

- **Tres problemas en estereología**

Conteo de partículas

Longitud de curvas

Volumen de dominios

- **Tres problemas en análisis de imagen médica**

Hospital La Fe de Valencia

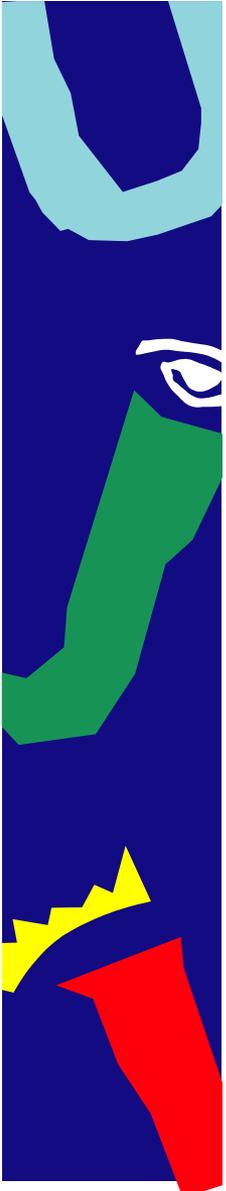
Programa GESTA

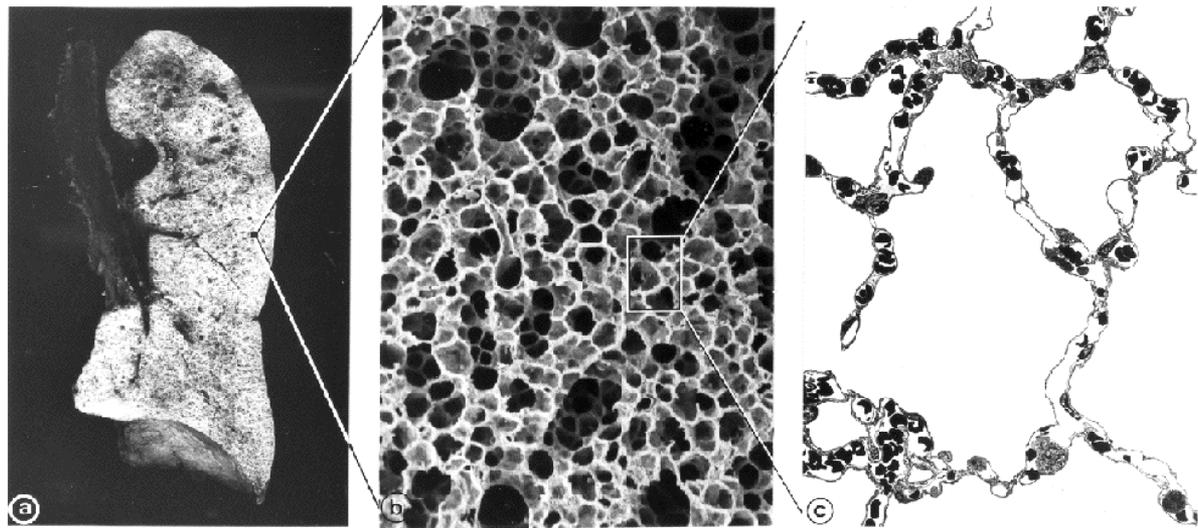
Análisis de glóbulos rojos (eritrocitos) deformados



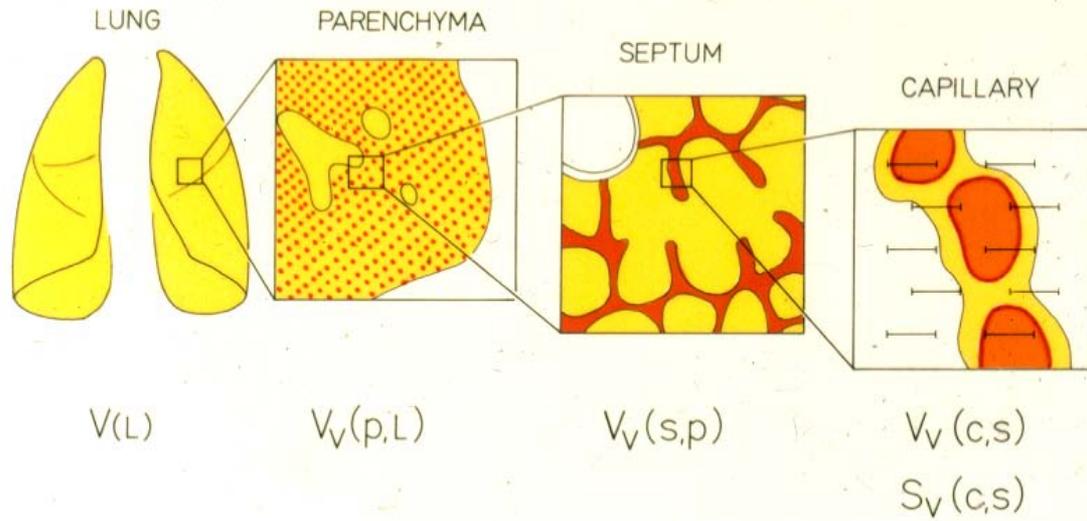
Estereología

- La estereología persigue la estimación cuantitativa de parámetros (volumen, área, longitud, número, etc) a partir de secciones o proyecciones.
- El análisis de imagen pretende conseguir la reconstrucción de objetos (propiedades cualitativas) a partir de secciones o proyecciones.





CASCADE SAMPLING



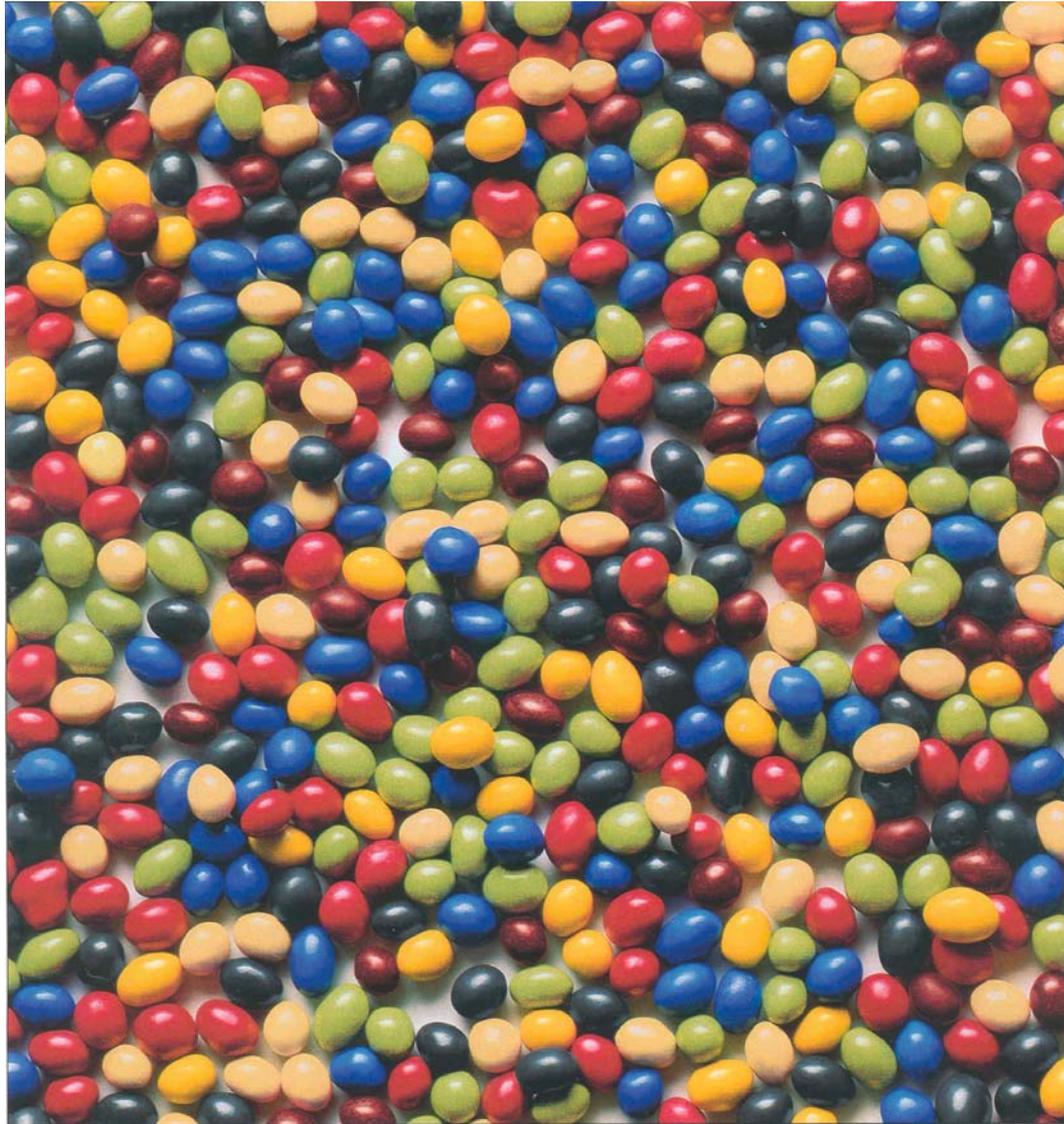
Microscopio de luz motorizado con el sistema CAST: Computer Assisted Stereology Toolbox





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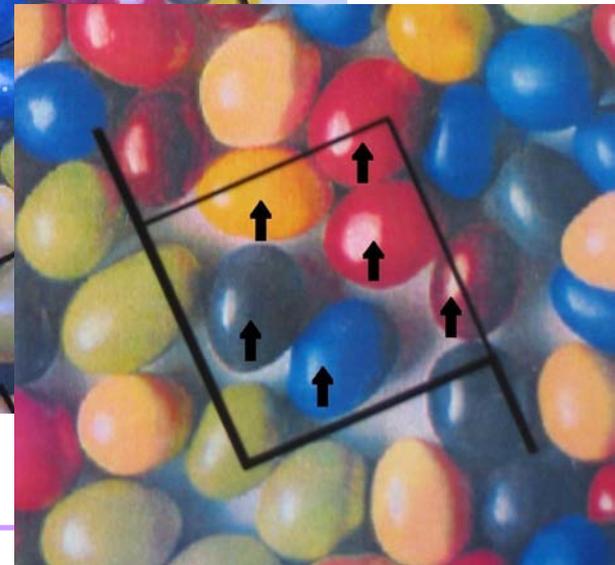
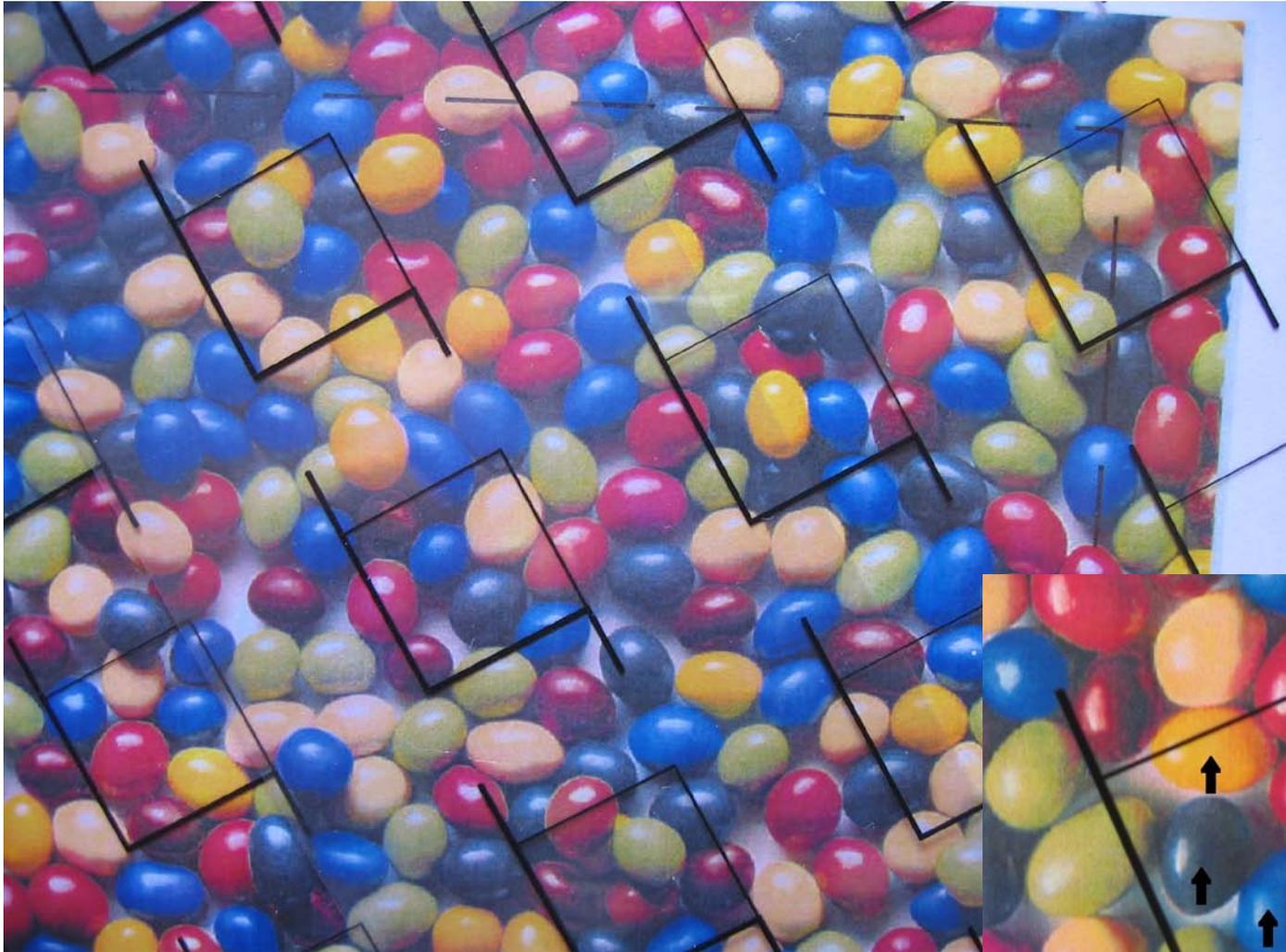
Conteo





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Conteo



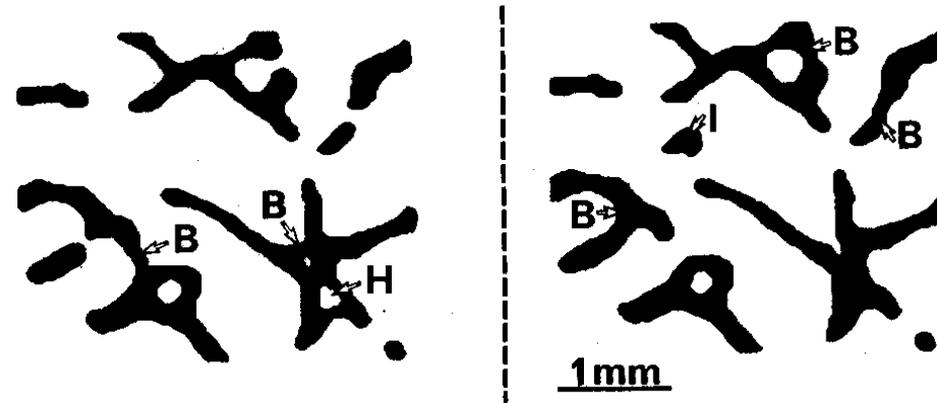
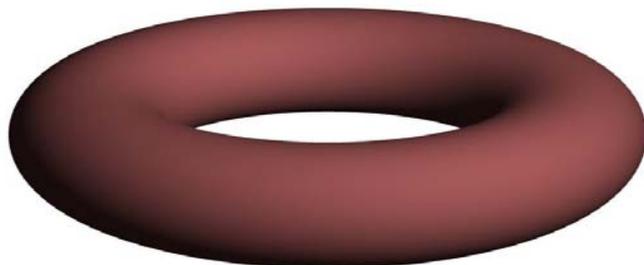


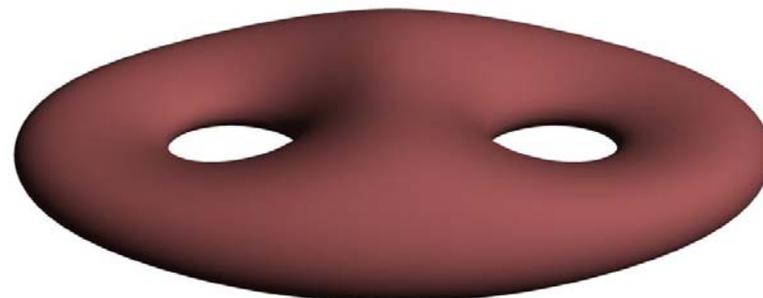
Fig. 1. Physical disector illustrating topological events in iliac cancellous bone as visualized in a section pair separated by $20\mu\text{m}$. The appearances on either side of "holes" (H), "islands" (I), and "bridges" (B) are indicated in the figure.



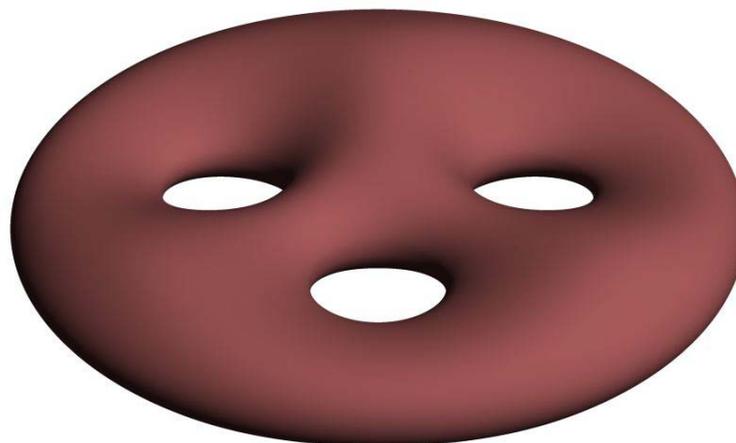
Superficie con $g=1$



Superficie con $g=2$



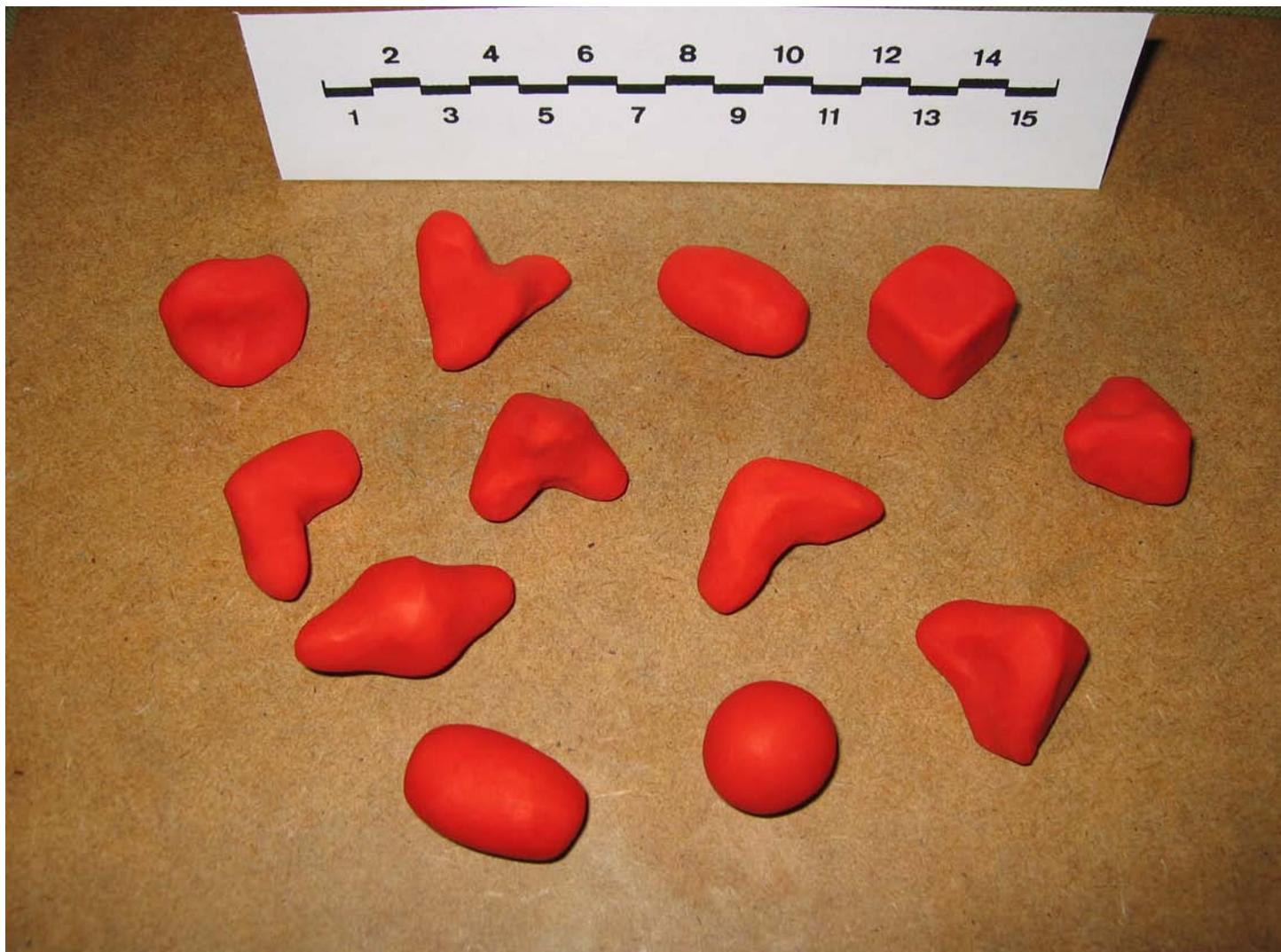
Superficie con $g=3$





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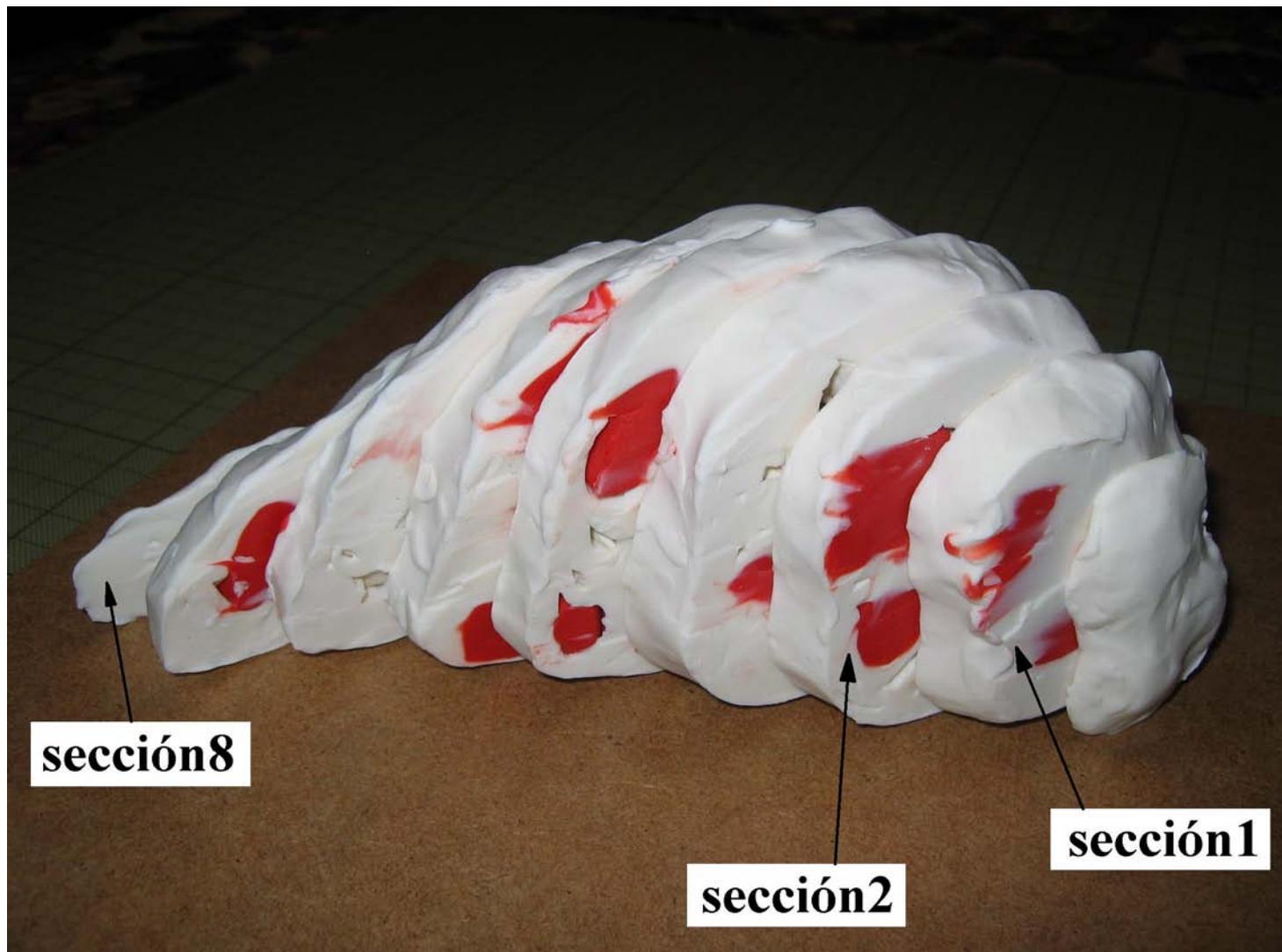


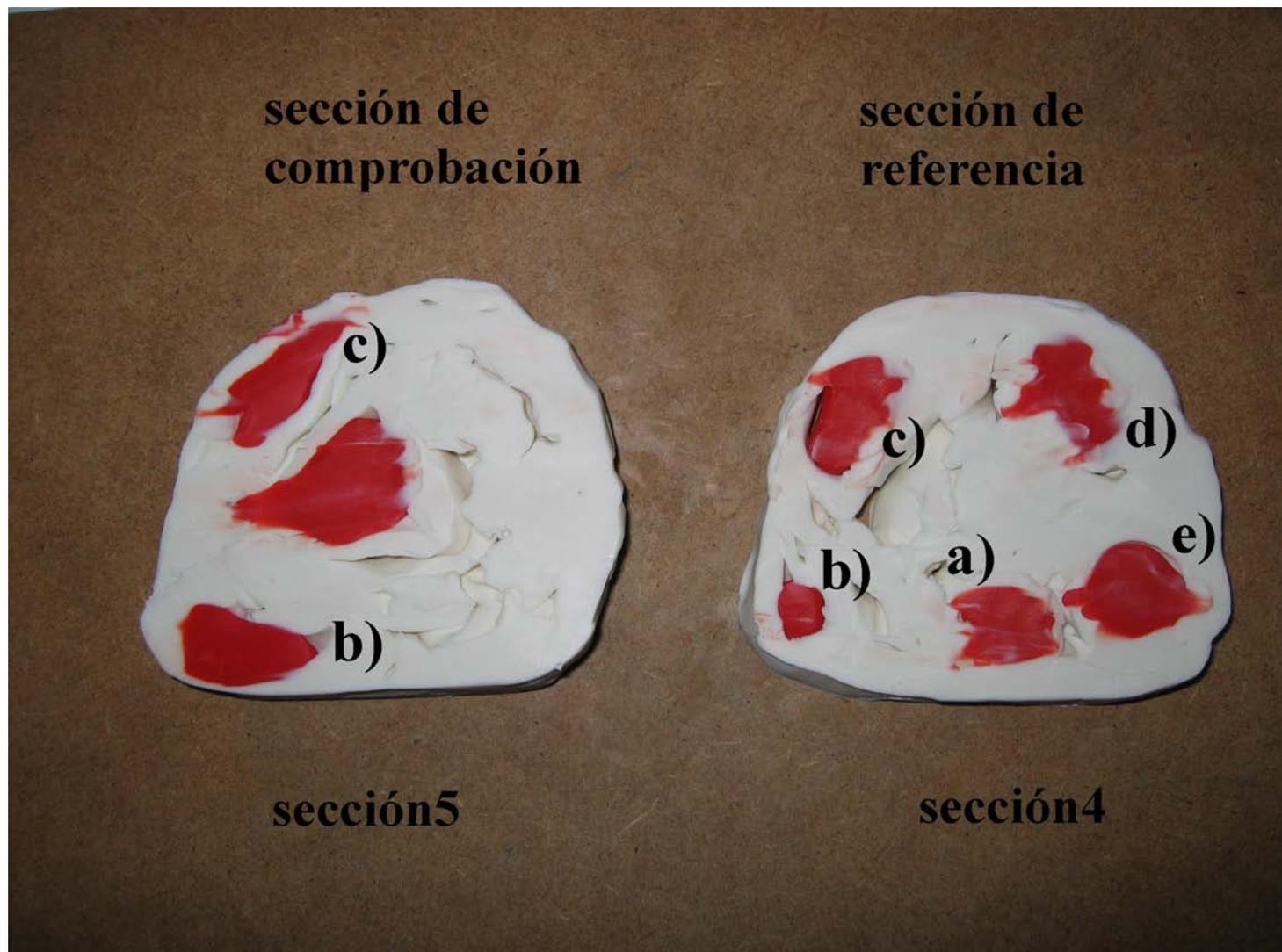


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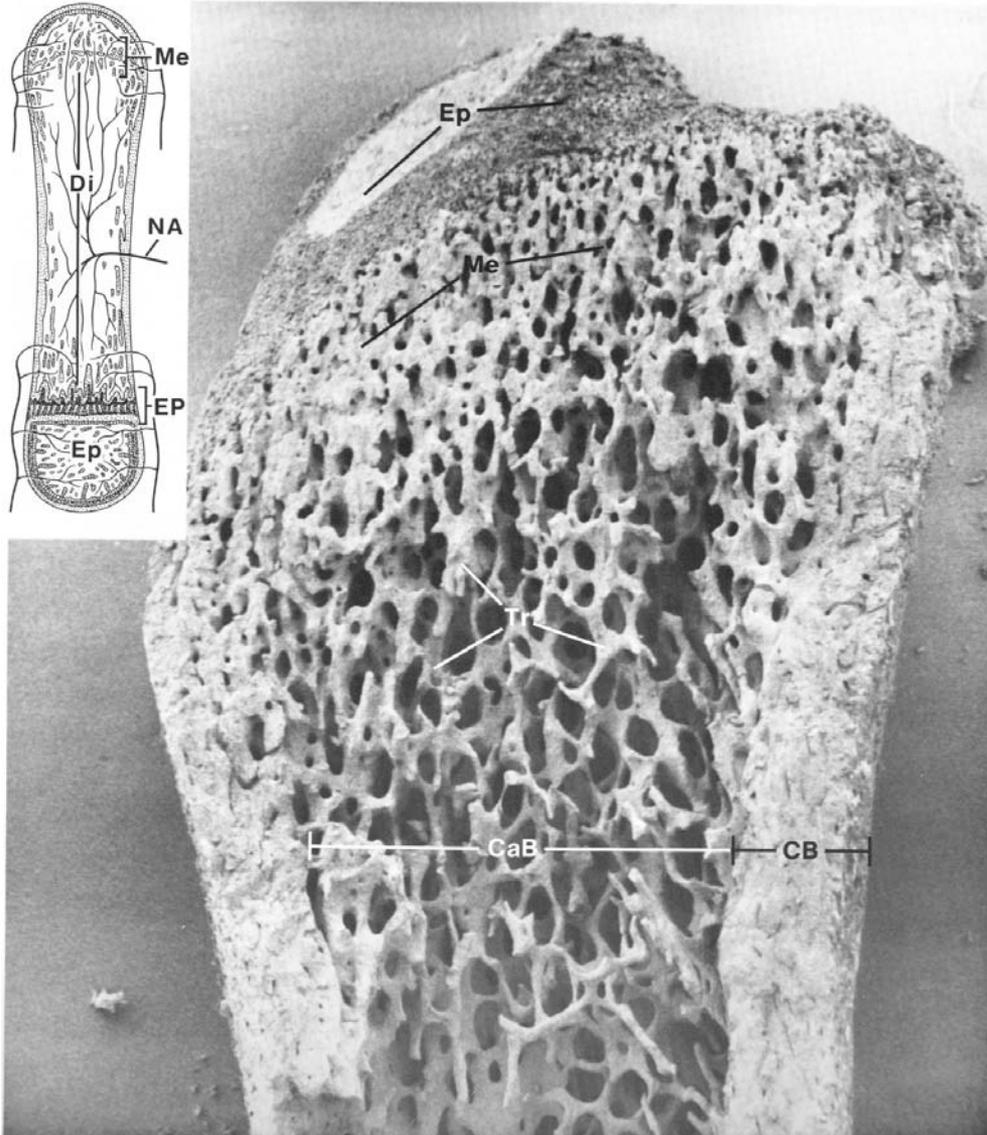






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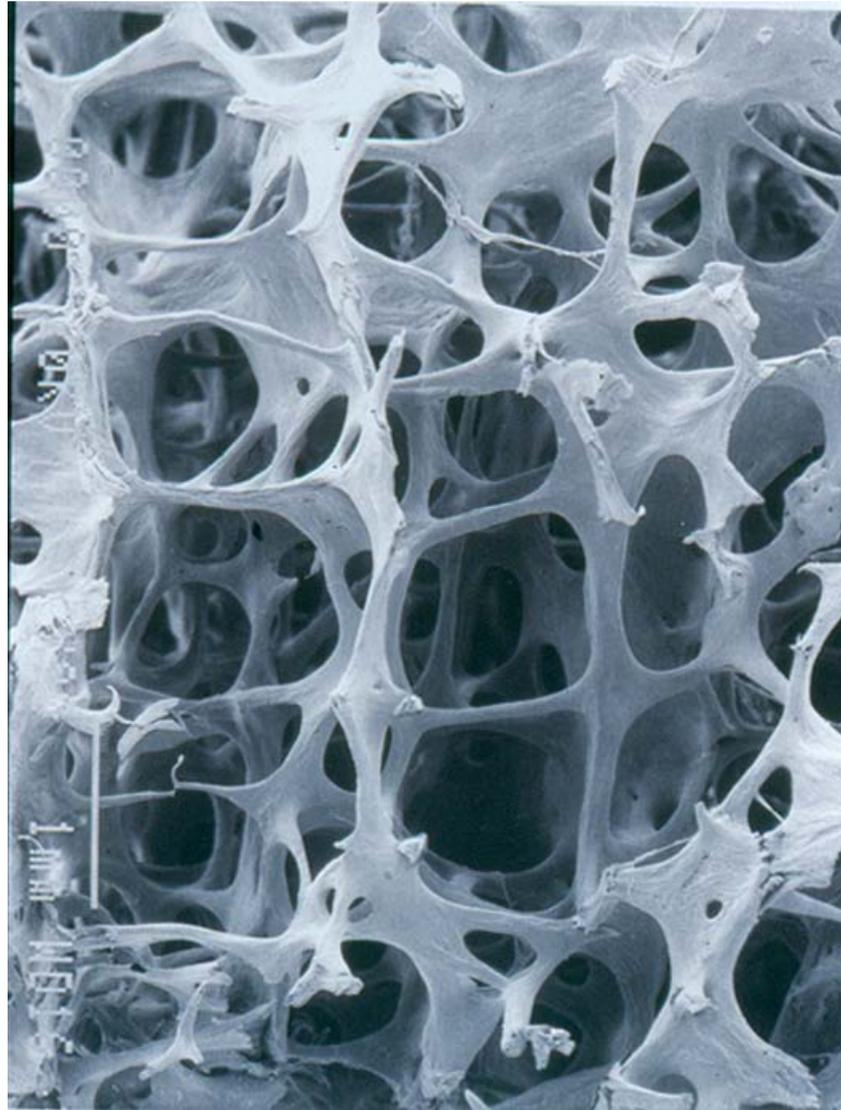
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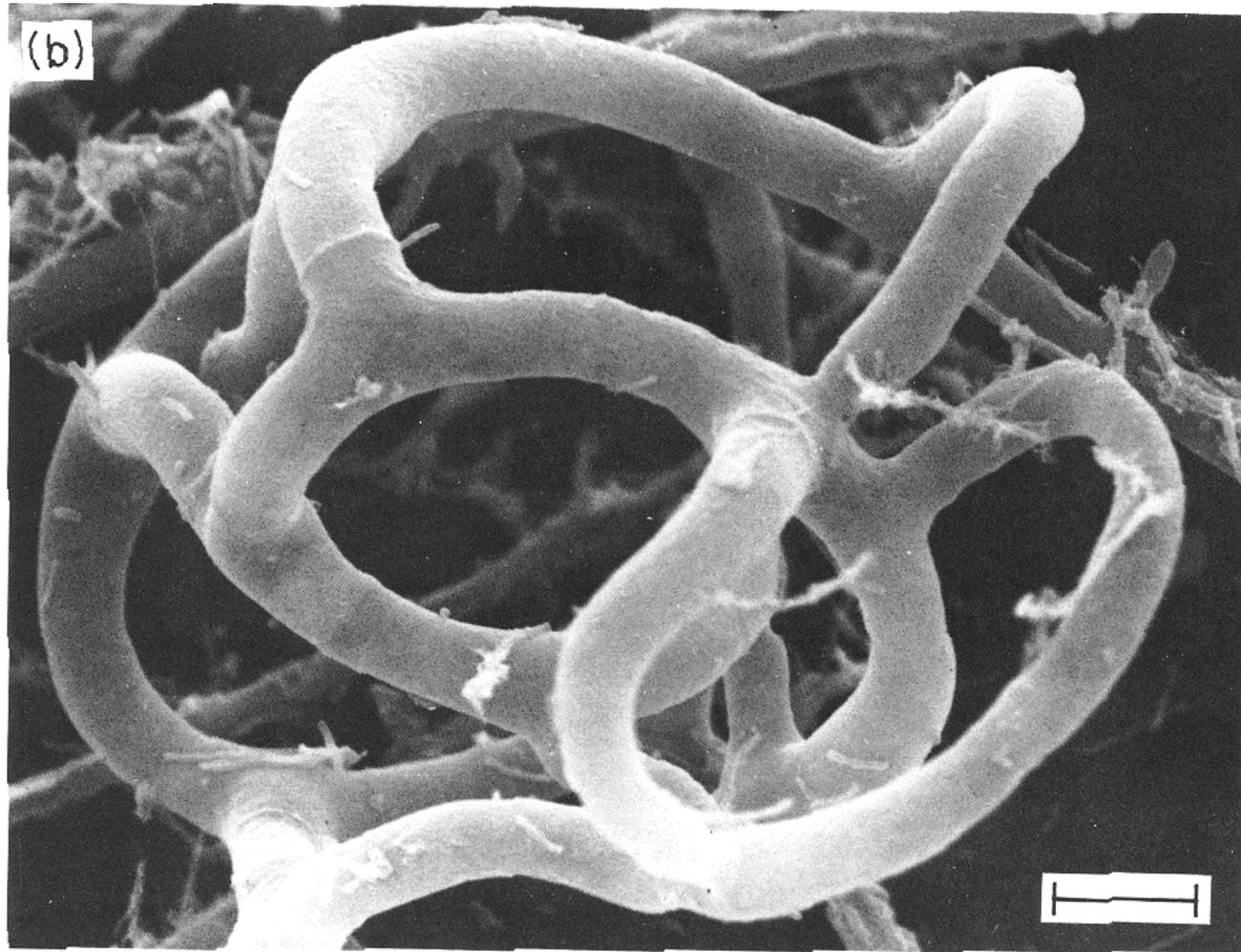


Fig. 1. (a) A simple trapping complex of *Arthrobotrys oligospora*. (b) A more complicated trapping complex of *A. oligospora*. Scale bars = 5 μm .



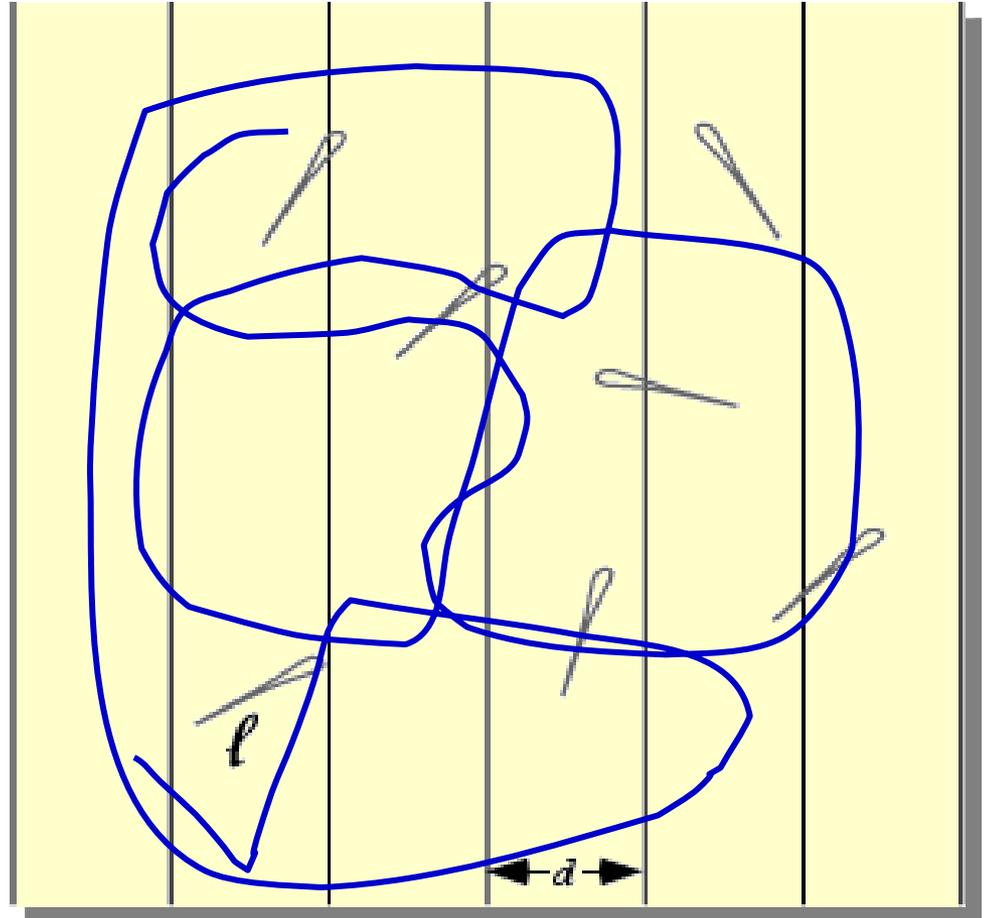
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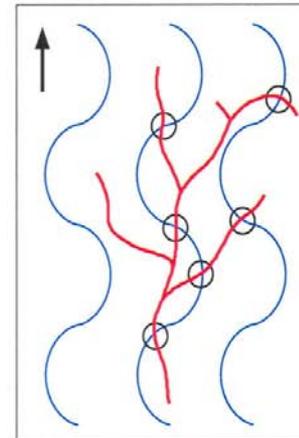
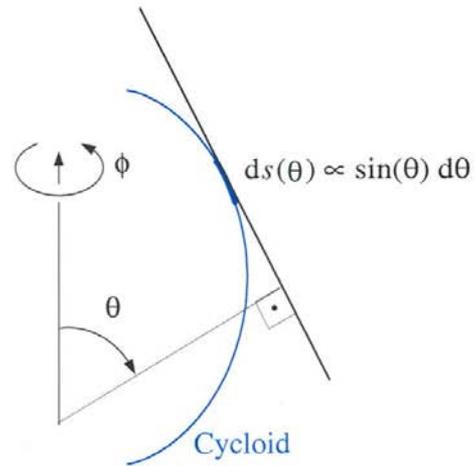
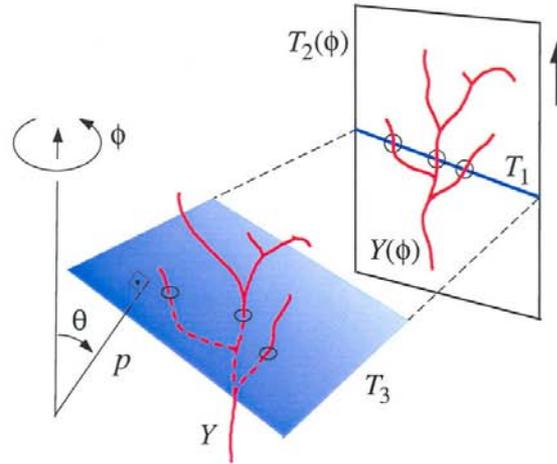
Longitud



Comte Georges Buffon (1707-1788)

$$L = \pi/2 \cdot d \cdot I$$

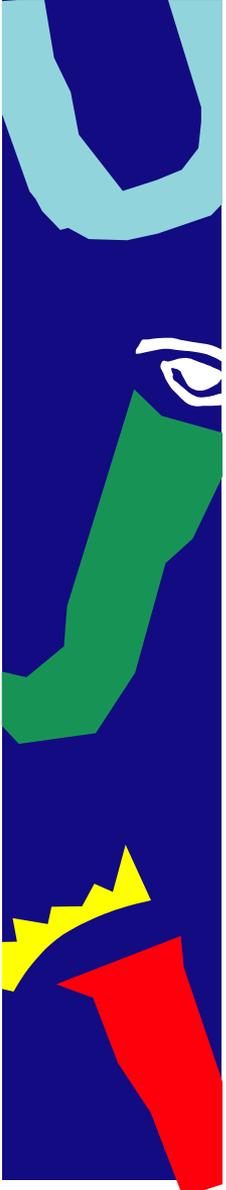
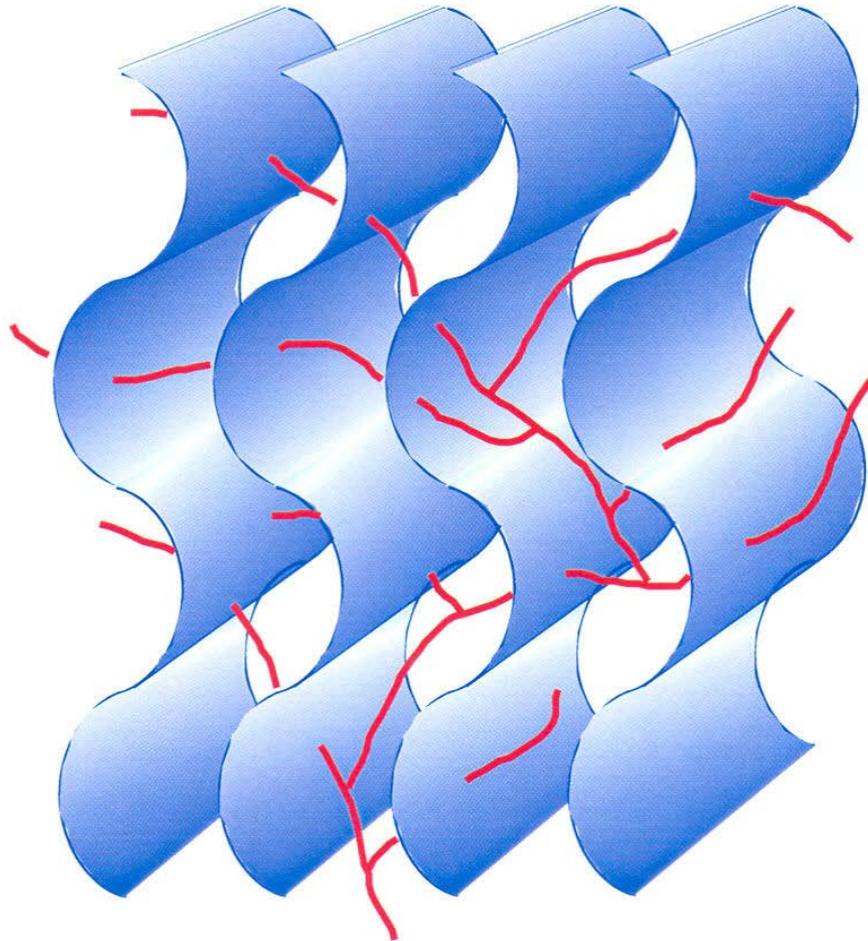


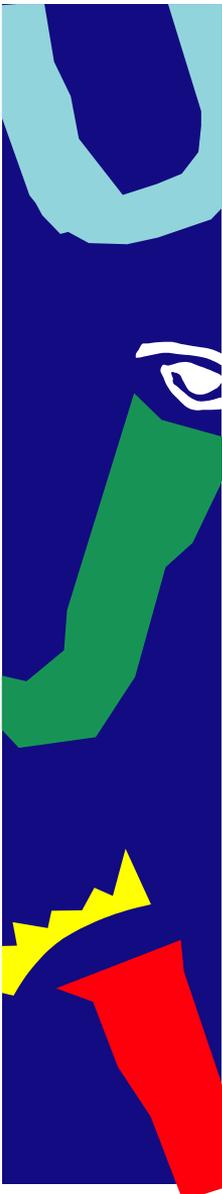
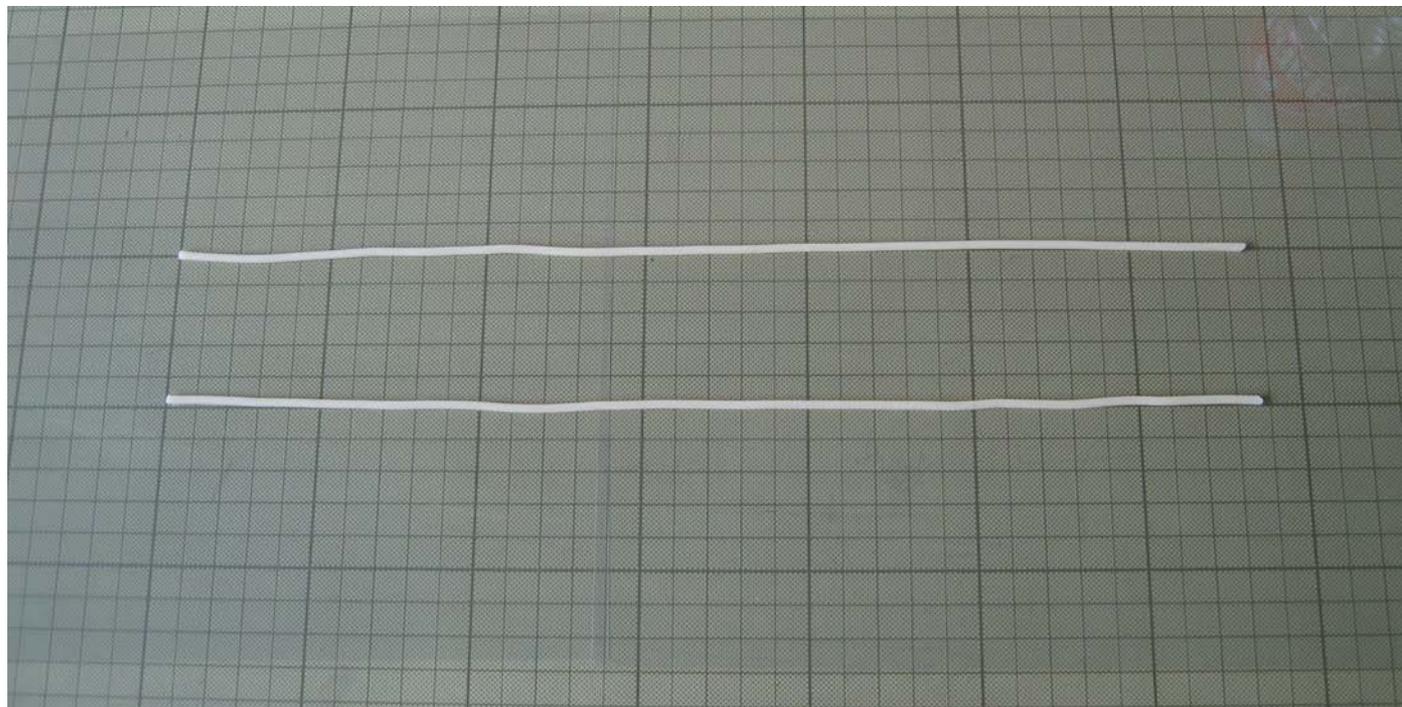




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Longitud

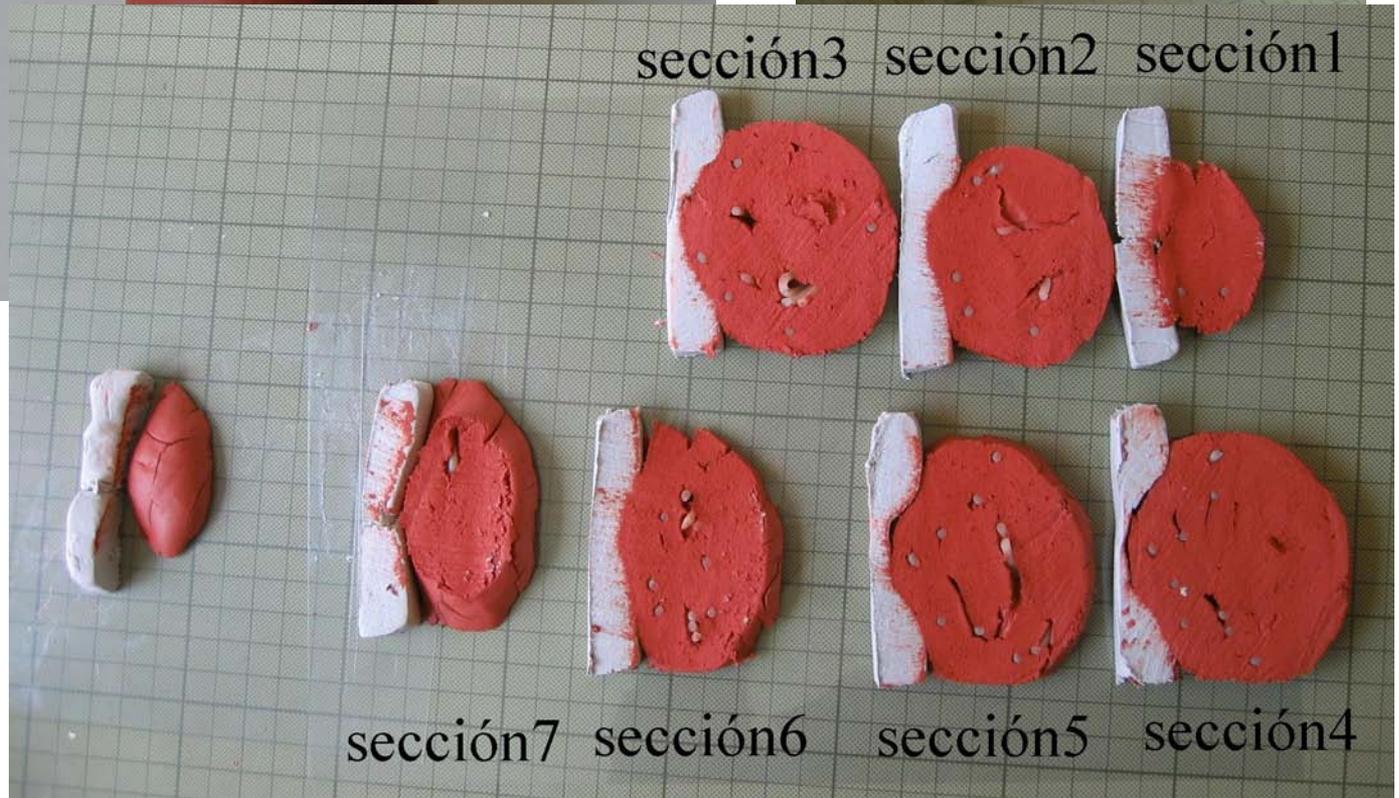
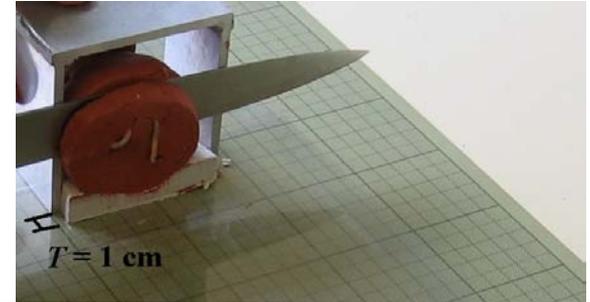






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Longitud



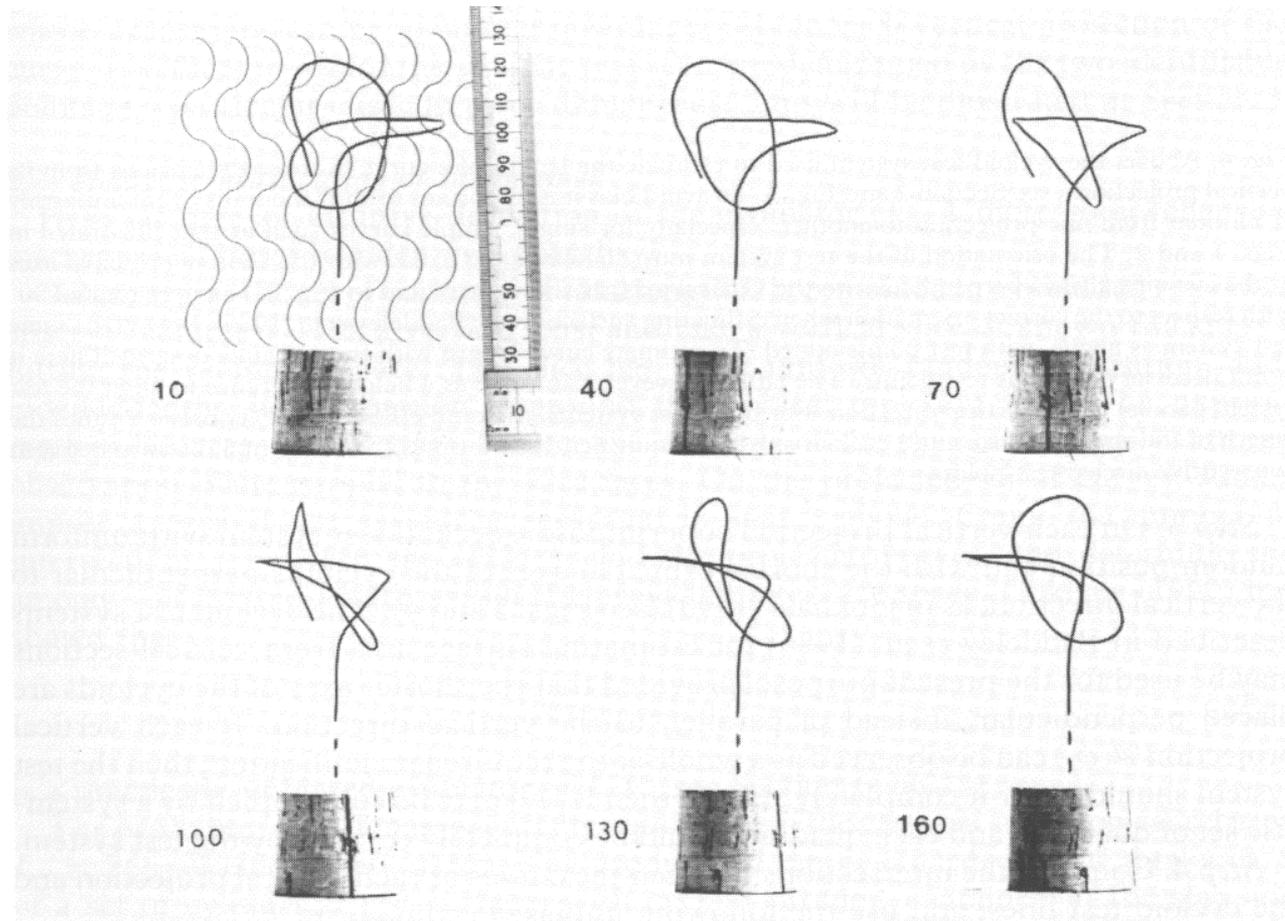


Fig. 3. A systematic sample $\{\mathcal{W}(\phi_j); \phi_j = 10 + (j - 1) \cdot 30, j = 1, 2, \dots, 6\}$ of six vertical projections of the twisted wire shown in Figs. 1 and 2. The straight, stippled piece of wire represents the vertical axis about which the wire was rotated by the angles $\{\phi_j\}$. From such flat projections, the length of the wire in three dimensions can be accurately estimated by intersection counting with a cycloid test system such as that superimposed on the first projection. See also Section 3, Table 1 and Fig. 4.

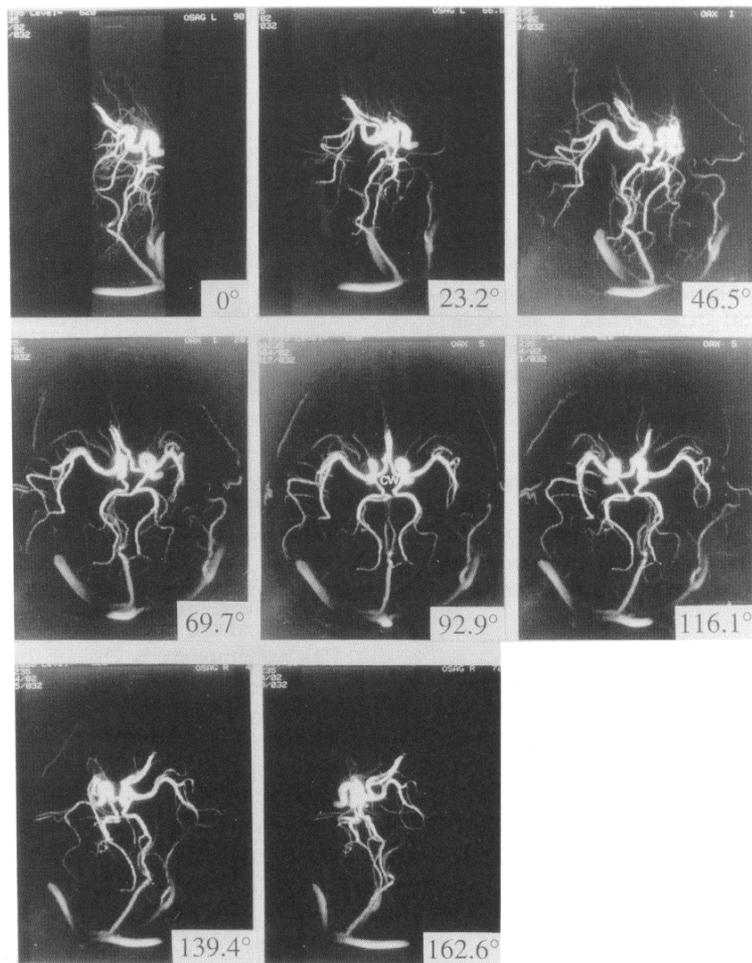
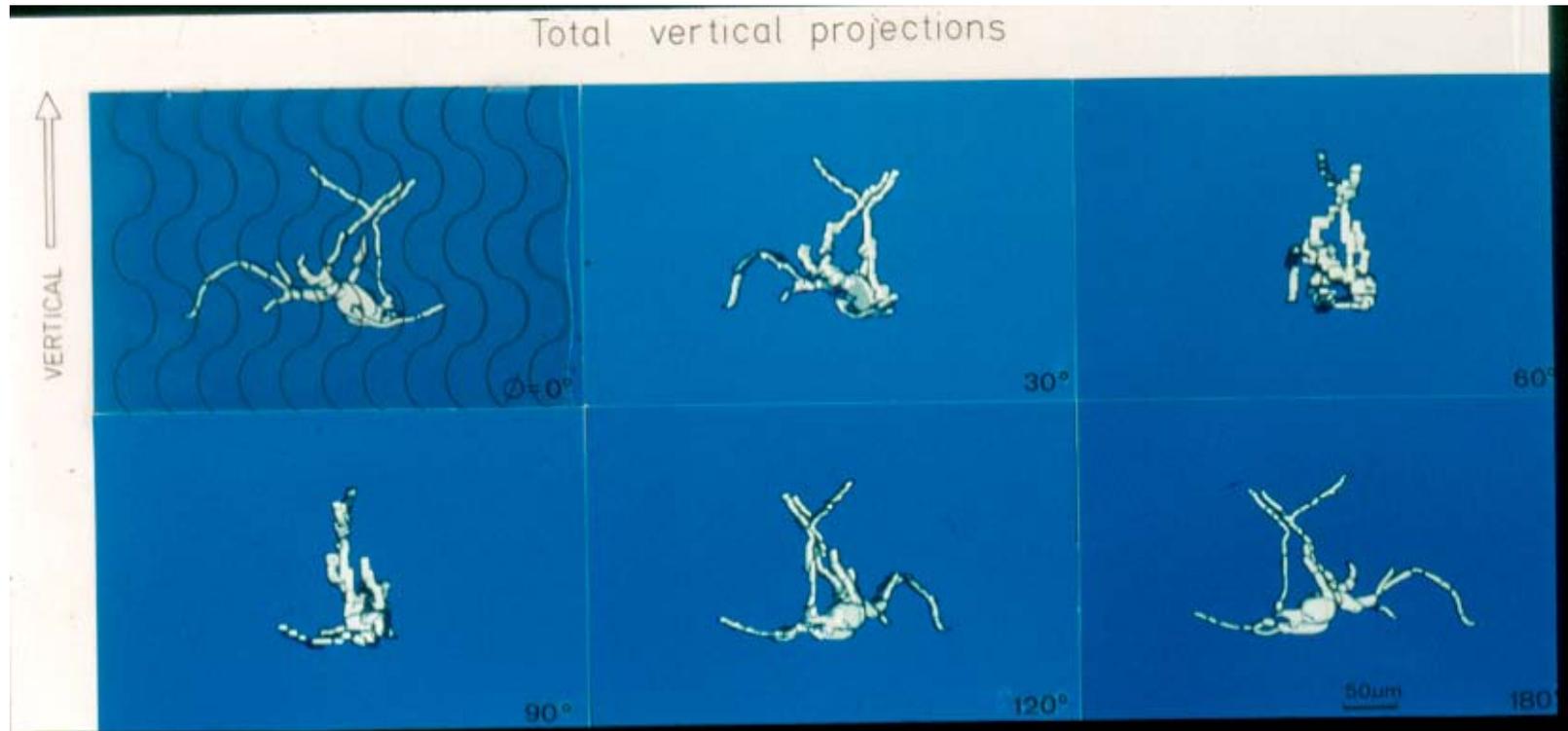
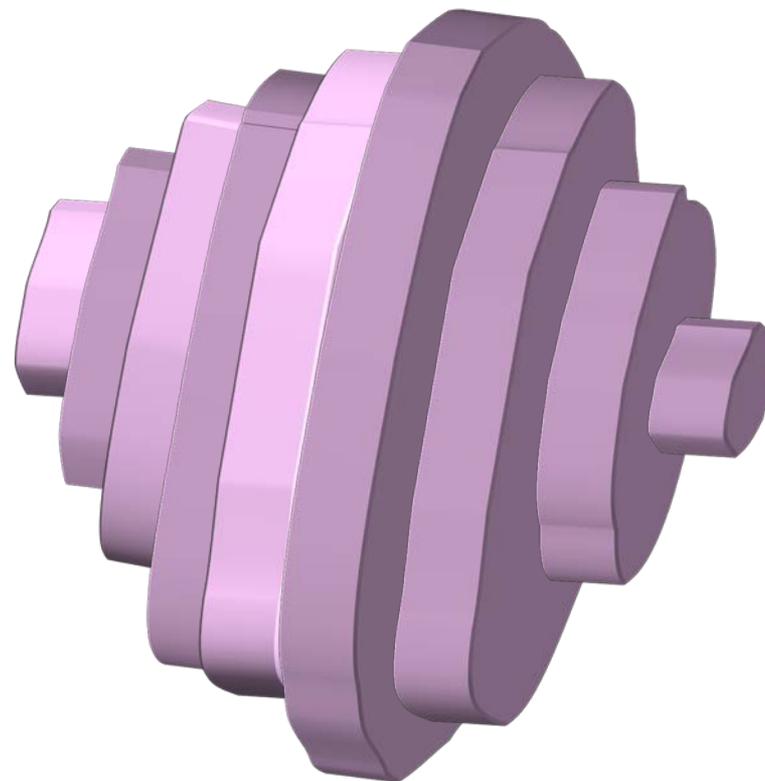


Fig. 5. Set of MRTVPs obtained by projecting 3D phase contrast MR angiography data, of a 5-cm thick slice through the head of an adult male, at $180^\circ/31$ intervals about a fixed vertical axis. The FOV of the images is 20 cm. Length estimates of the Circle of Willis (CW) and of the vessels are displayed in Table 4.



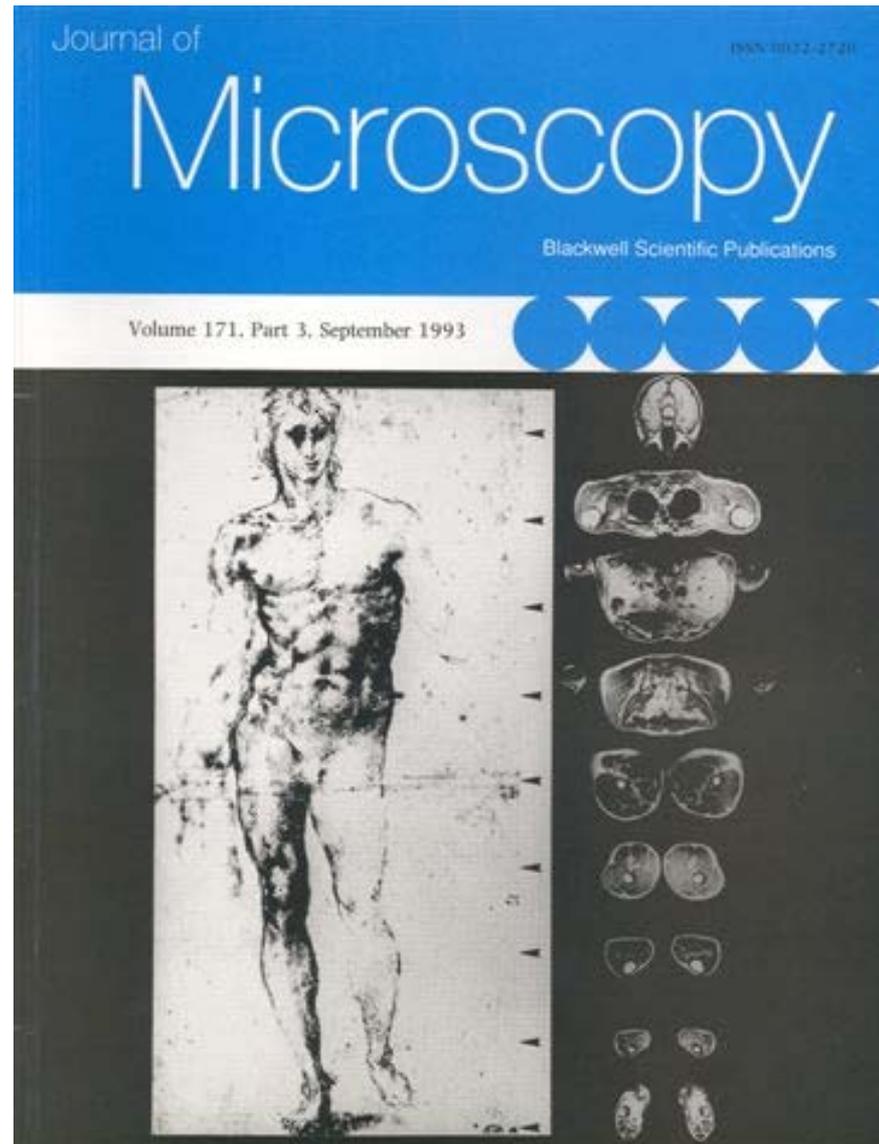


Bonaventura Cavalieri nació en Milán en 1598



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Volumen





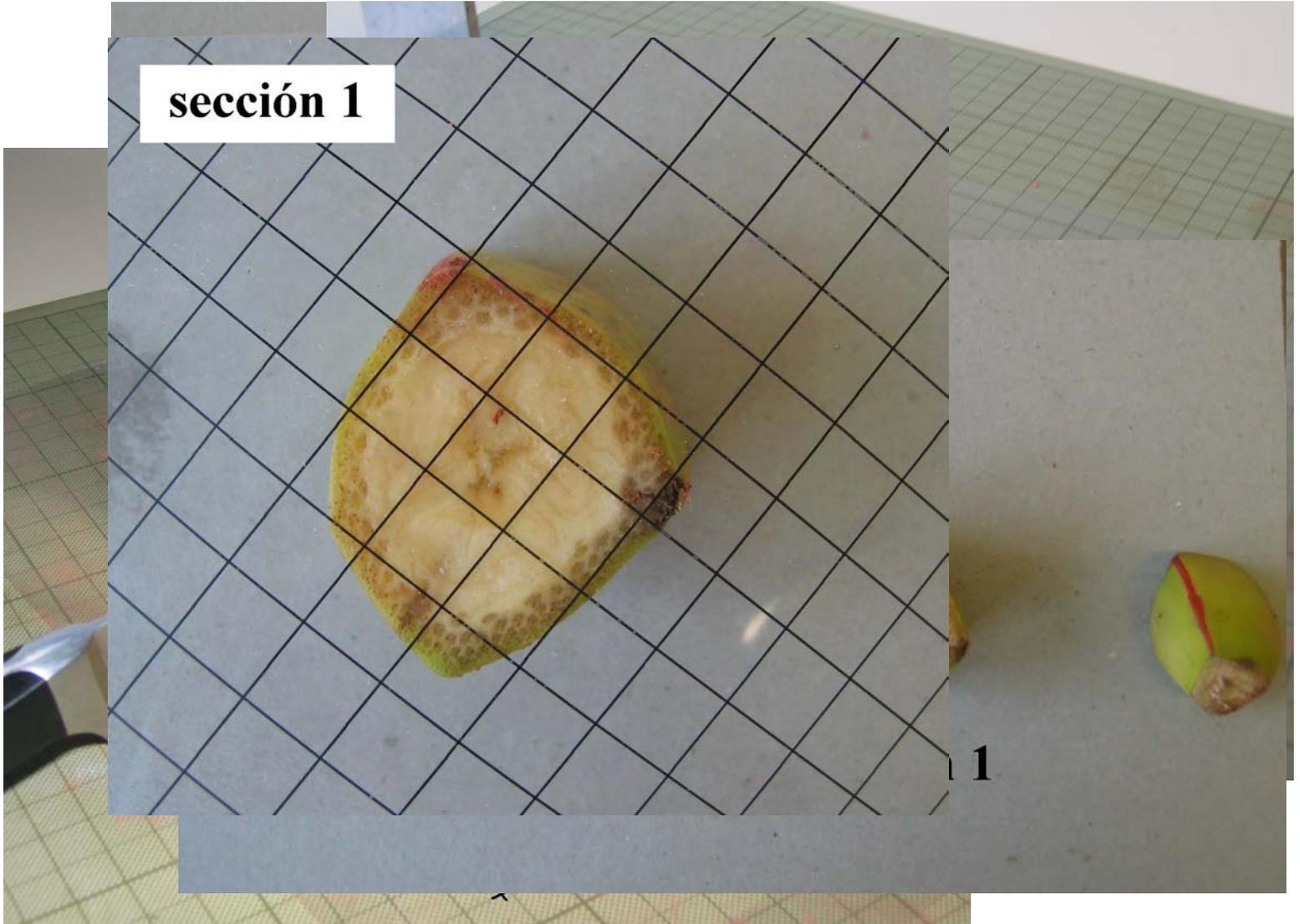
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Volumen



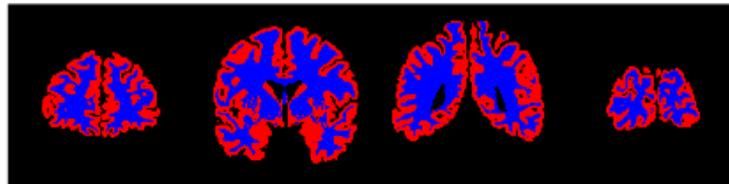
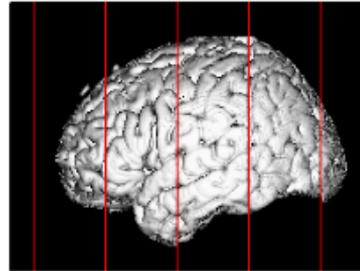


sección 1

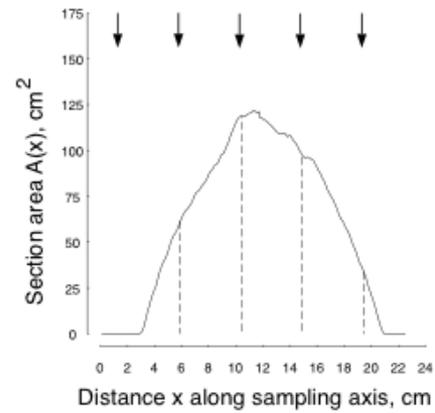




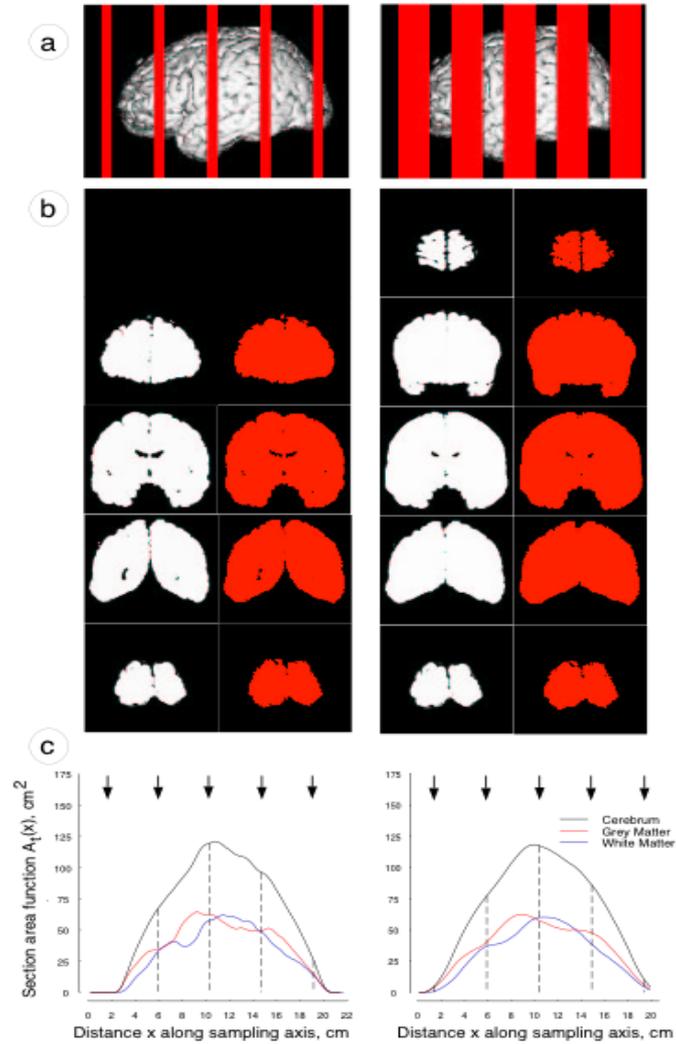
a



b



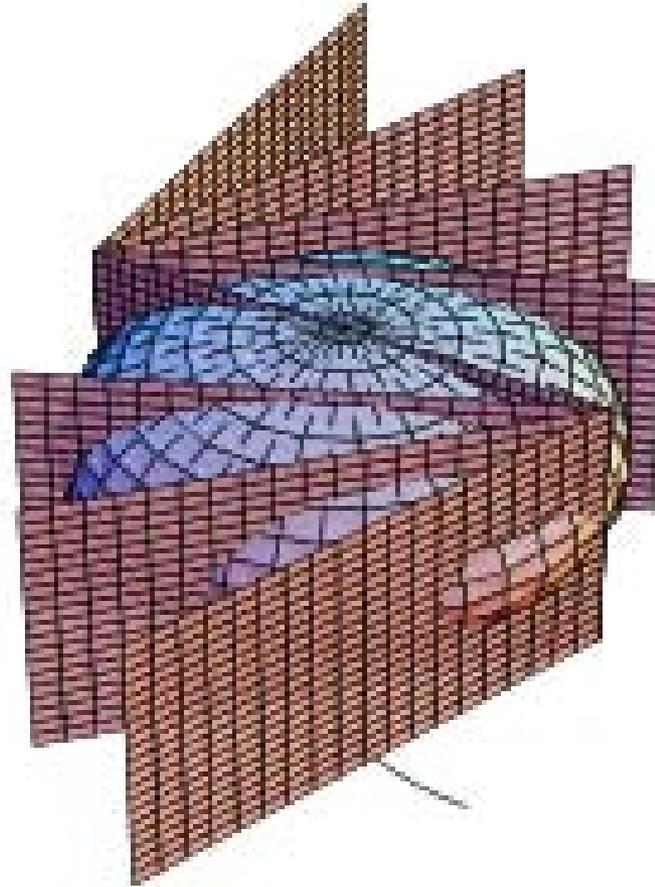
c





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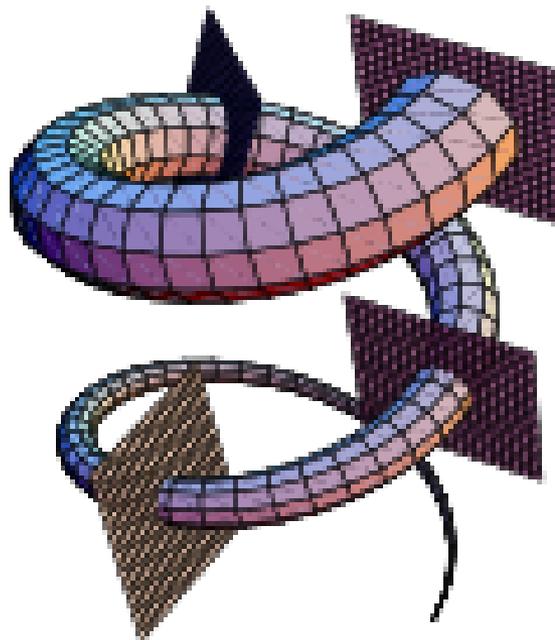
Volumen





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Volumen





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Análisis de Imagen



Segmentación manual de un tumor de pulmón



Segmentación automática

- Operadores morfológicos: 'Opening' y 'Closing'





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Segmentación automática



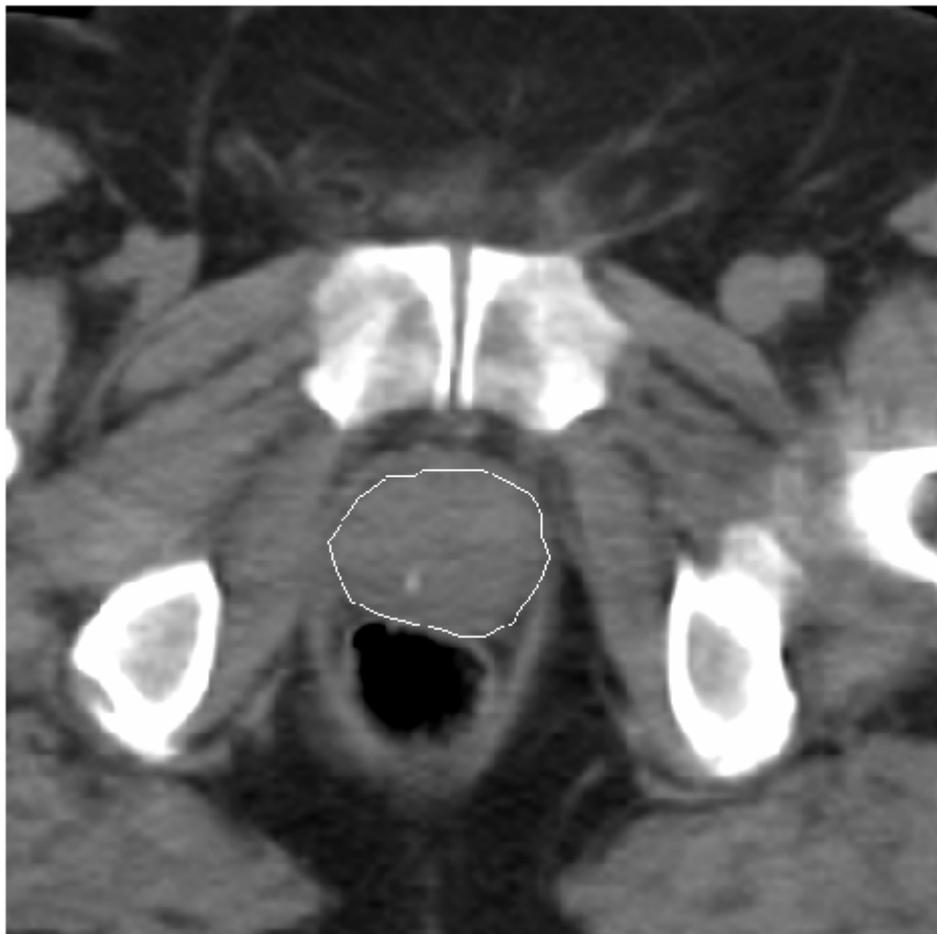
Negro: segmentación automática.

Blanco: segmentación manual



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Variabilidad del observador



Segmentación manual de la próstata



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Variabilidad del observador



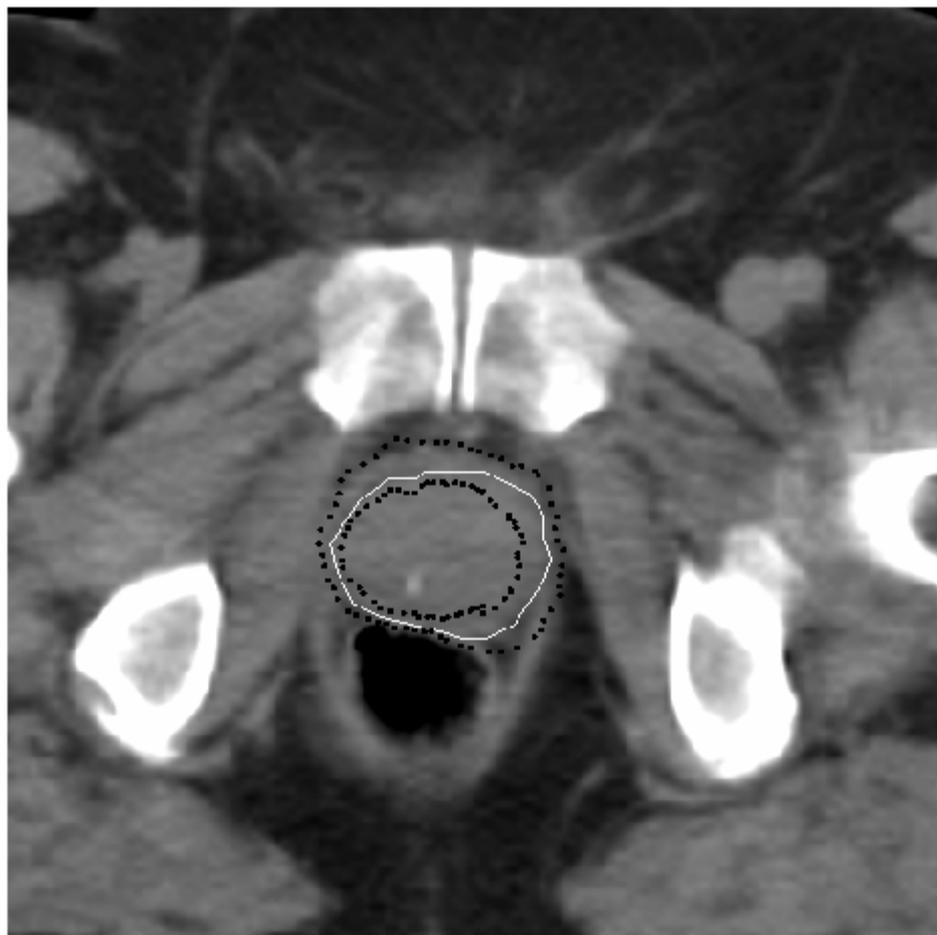
Blanco: Segmentación manual.

Negro: Contorno medio con vectores normales



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Variabilidad del observador

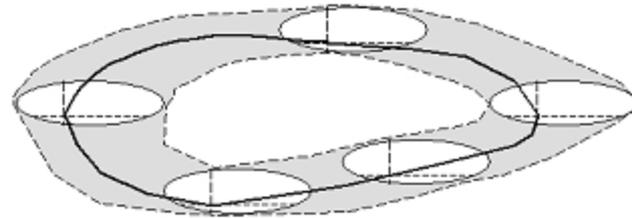
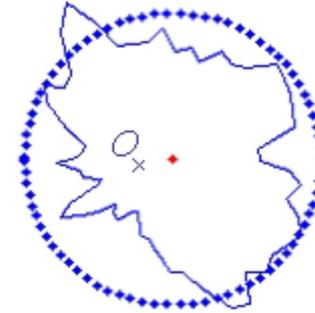
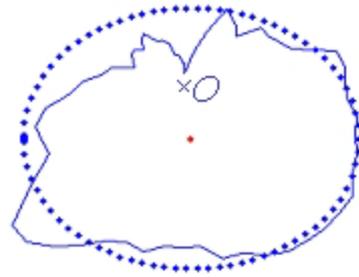


Tubo de radio no constante alrededor del contorno medio



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Variabilidad del observador

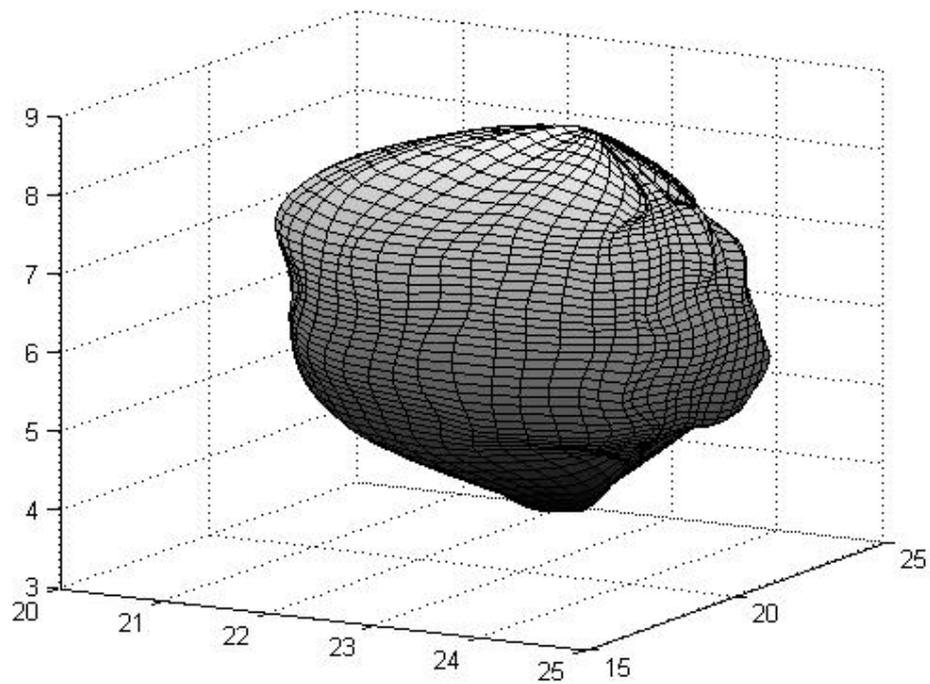


Márgenes de confianza obtenidos con una elipse

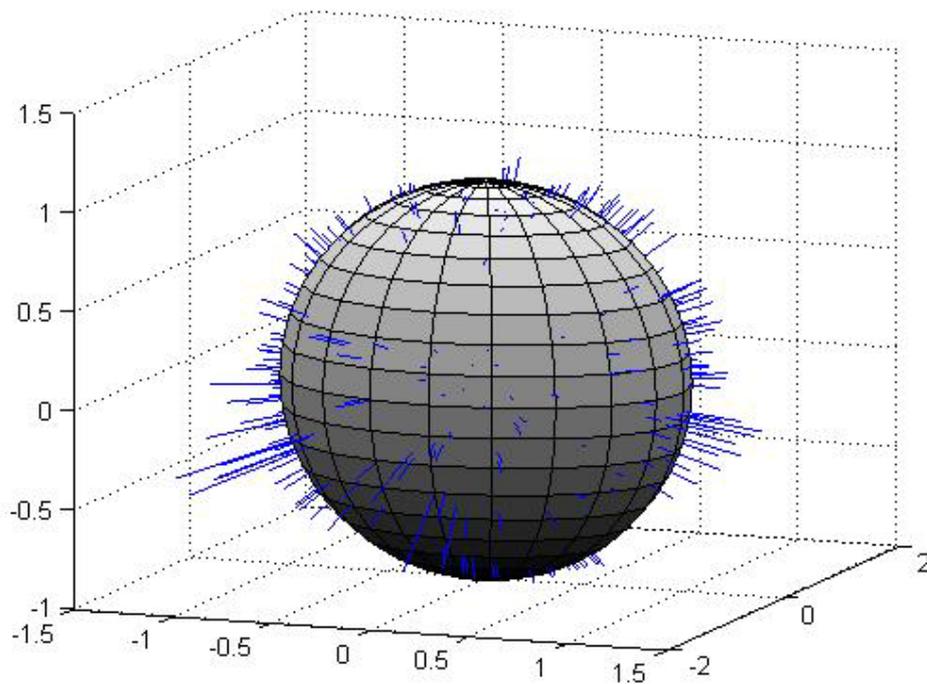


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3D



Próstata 'media'

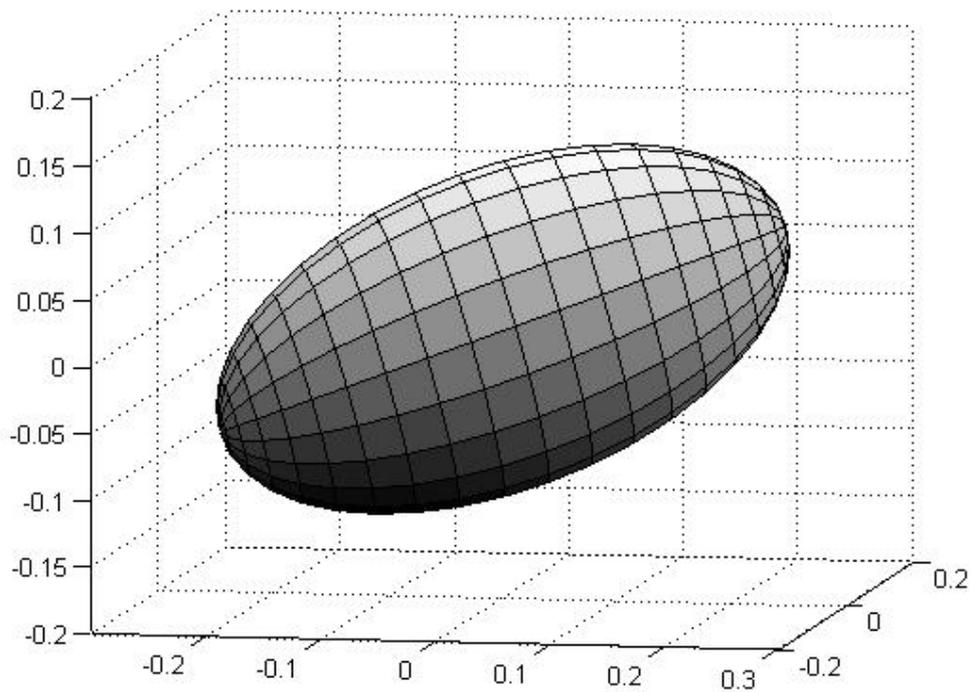


Desviación típica



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3D



Elipsoide



Programa GESTA ‘Generación de Soluciones de Tecnología Avanzada’

Proyecto: Identificación de la esteatosis hepática y determinación del grado de afectación mediante ecografía.

Entidades participantes: Carabos Cooperativa Valenciana, UJI, Hospital La Fe de Valencia, Generalitat Valenciana, FEDER.

2006-2007



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GESTA

VILATA BALAGUER, IVAN

06.09.14-13:17:54-H...

14/09/2006

13:43:00

CH4-1
ABDOMEN
10fps

THI/1.8 MHz
10dB/DR60
RS3/SC2

H. "LA FE"



B

17cm
10cps

Fr681

SIEMENS



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GESTA

VILATA BALAGUER, IVAN

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14/09/2006

13:41:24

CH4-1
ABDOMEN
10fps

THI/1.8 MHz
5dB/DR60
RS3/SC2

H. "LA FE"





Adquisición de imágenes



Determinación de contornos



Análisis granulométrico



Agrupamiento de resultados



La Sicklemlia es una enfermedad crónica que genera la deformación y pérdida de flexibilidad del eritrocito en sangre.

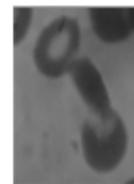
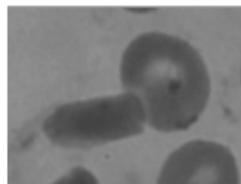
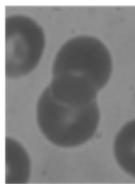
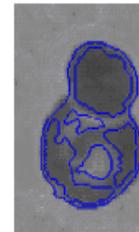
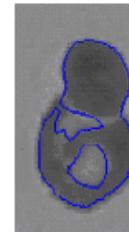
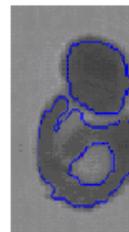
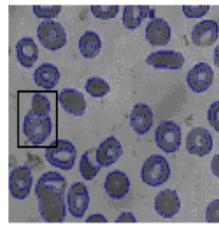
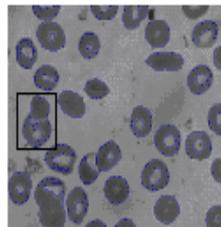
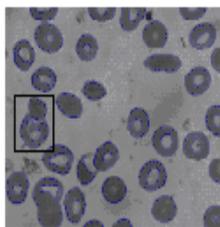


Glóbulo Rojo en Hoz (falciforme)

Glóbulo Rojo Normal

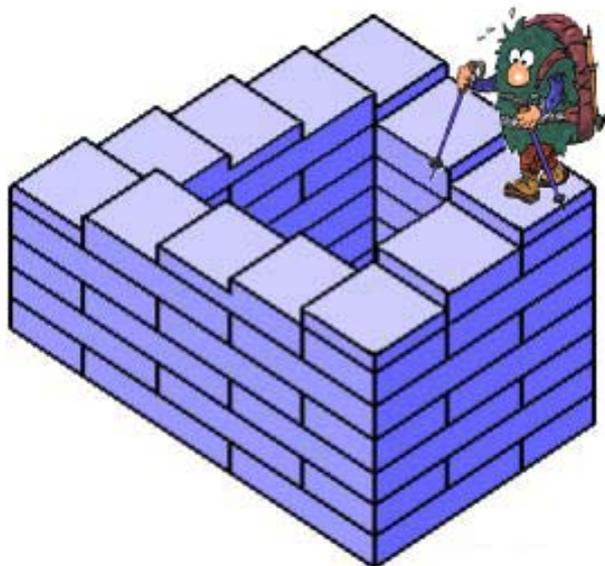


Problema: Determinar y clasificar los eritrocitos deformados mediante imágenes digitales de muestras de sangre, detectando de forma automatizada las fórmulas mediante el empleo de técnicas de procesamiento de imágenes.





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Gracias!!